Gravity waves:

$$\frac{\partial \vec{v}'}{\partial t} = -\nabla_h \Phi' \quad (1)$$

$$\frac{\partial}{\partial t}\left(\frac{\partial \Phi'}{\partial p}\right) = -\omega'\sigma \quad \text{Thermo} \ (3)$$

$$\nabla_h \cdot \vec{V}' = -\frac{\partial \omega'}{\partial p} \quad (2)$$

$$\frac{\partial \Phi'}{\partial p} = -\frac{R_d T'}{p}$$

$$\sigma = \frac{R_d S_p}{p C_p}$$

static stability param

like N^2 in p-coords

How can we combine these equations into one

Taking $\nabla_h \cdot (1)$ yields

$$\delta = \nabla_h \cdot \vec{v}$$

$$\frac{\partial \delta}{\partial t} = -\nabla_h^2 \Phi \quad \text{Div. Eqn.}$$

$$\delta = -\frac{\partial \omega}{\partial p}$$

$$-\frac{\partial^2 \omega}{\partial t \partial p} = -\nabla_h^2 \Phi \quad \checkmark \quad (4)$$

Let's take $\partial^2/\partial t \partial p$ of Eq. (3)

$$\frac{\partial^2}{\partial p \partial t}\frac{\partial}{\partial t}\left(\frac{\partial \Phi'}{\partial p}\right) = -\sigma \frac{\partial^2 \omega}{\partial p \partial t} = \sigma \nabla_h^2 \Phi$$

$$\frac{\partial^4 \Phi'}{\partial p^2 \partial t^2} = -\sigma \nabla_h^2 \Phi' \quad \text{"savage!" - HC}$$

Let's assume σ is a constant.

$$\Phi = \hat{\Phi} \exp(ikx + ily + imp - i\omega t)$$

$$\frac{\partial^2 \Phi}{\partial p^2} = -m^2 \Phi \quad \text{(recall antitriptic balance class)}$$

$$(-m^2)(-\omega^2)\cancel{\Phi'} = -\sigma(-k^2 - l^2)\cancel{\Phi} \qquad K^2 = k^2 + l^2$$

$$m^2 \omega^2 = \sigma K^2$$

$$\omega = \frac{K\sqrt{\sigma}}{m}$$

m = TBC

$$c = \frac{\omega}{K} = \frac{\sqrt{\sigma}}{m} = 50 \ ms^{-1}$$

gravity wave phase speed